Rev. Écol. Biol. Sol, 1969, T. VI, 2, p. 147-153.

Studies on fungi in a pinewood soil IV. — Seasonal and spatial variations in the fungal populations

BY

D. PARKINSON

(Department of Biology and Environmental Sciences Centre, University of Calgary, Calgary, Alberta, Canada)

I. BALASOORIYA

(Department of Botany, Vidyalankara University of Ceylon, Kelaniya, Ceylon)

INTRODUCTION

In view of the conflicting evidence regarding the existence and extent of seasonal fluctuations in the qualitative and quantitative nature of the mycofloras of natural soils (WARCUP, 1951; THROWER, 1954; WILLIAMS and PARKINSON, 1964), an investigation was made on the extent of such seasonal changes in the pinewood soil at Freshfield, Lancashire.

Previous evidence (KENDRICK and BURGES, 1962 ; WILLIAMS, 1962 ; WILLIAMS and PARKINSON, 1964) from the Delamere pinewood soil has been that in the L, F_1 and F_2 layers of the A_0 horizon a distinct successional pattern of colonization and exploitation occurs on freshly fallen pine needles. However, in the H layer and in the mineral horizons of the Delamere soil it has been shown that qualitative and quantitative fluctuations in the mycofloras within the sampling site at any one time were at least as great as any seasonal fluctuations that were recorded. Preliminary studies on the Freshfield soil in the present investigation indicated similar trends, therefore a detailed comparative assessment was made of the extent of spatial and seasonal fluctuations in the H layer and the A_1 and C horizons. The results of this investigation are reported here.

* Reçu le 6-5-68.

METHODS

To assess the extent of seasonal variation occurring in the fungal populations, sampling of the various horizons of the Freshfield soil (L, F_1, F_2 and H layers, A_1 and C horizons) was carried out at bimonthly intervals over a 13 month period. As in previous studies (PARKINSON and BALASOORIYA, 1967; BALASOORIYA and PARKINSON, 1967) the C horizon was sampled at 2 depths, designated C_1 and C_2 for convenience.

TABLE I

Seasonal fluctuations of colonization index and moisture content in the different horizons of the freshfield soil

Sampling Time	A_0 Horizon							
	L		F_1		F_2		H	
	Col. Index	% Moist.	Col. Index	% Moist.	Col. Index	% Moist.	Col. Index	% Moist.
October	0	30	0	42	60	58	236	58
December	120	34	160	55	148	56	184	56
February	0	50	0	52	80	66	100	54
April	2	25	168	58	192	58	200	58
June	55	12	164	16	268	21	236	48
August	1	19	0	30	160	68	172	51
October	1	36	184	51	188	69	140	60

Sampling Time	A_1 Horizon		C Horizon			
			C_1		C_2	
	Col. Index	% Moist.	Col. Index	% Moist.	Col. Index	% Moist.
October	16	3.8	0	1.2	0	1.4
December	116	7.0	24	3.8	22	3.2
February	52	5.4	1.0	4.1	1	4.1
April	92	7.0	109	5.5	68	5.3
June	76	2.8	56	1.1	3	1.0
August	0	2.0	0	2.0	3	1.9
October	118	8.2	84	5.0	1	1.0

TABLE II

Seasonal variations in percentage frequency of occurrence of dominant fungi in the different layers and horizons of the freshfield soil (figure indicate % frequency of occurrence)

Sampling Zone	Dominant Fungi	Sampling time						
		Oct.	Dec.	Feb.	Apr.	Jun.	Aug.	Oct.
L layer	*Fusicoccum bacillare*	74	96	36	96	78	70	32
	Aureosbasidium pullulans	12	15	—	02	24	14	03
F_1 layer	*Fusicoccum bacillare*	02	11	50	58	10	0	26
	Polyscytalum sp.	22	18	08	08	54	10	02
	Dark Sterile DSL I	48	08	02	26	16	64	78
	Mortierella isabellina	—	03	—	20	30	02	22
	Bisporomyces	14	18	—	—	—	02	02
	Trichoderma viride	—	25	—	26	30	—	04
	Penicillium spp.	—	60	—	26	68	—	22
F_2 layer	*Trichoderma viride*	10	44	48	76	90	92	35
	Mucor hiemalis	14	49	08	—	06	08	21
	Penicillium spp.	38	37	30	88	86	42	44
	Mortierella spp.	16	08	0	01	18	0	16
	Bisporomyces sp.	04	06	02	06	16	0	12
	Polyscytallum sp.	36	14	26	06	14	0	12
H layer	*Trichoderma viride*	92	37	31	84	78	82	40
	Mortierella marburgensis	52	68	0	29	20	0	02
	M. hygrophila	14	05	—	21	06	—	12
	Penicillium lividum	16	04	08	05	—	—	18
	P. citrinum	16	20	36	34	18	28	22
	P. spp. (total)	69	61	70	76	86	78	70
A_1 horizon	*Penicillium decumbens*	23	08	62	41	68	01	39
	Trichoderma viride	0	21	01	06	01	0	26
	Oidiodendron fuscum	04	02	—	14	06	01	01
	Dark Sterile GRN	06	07	04	10	02	—	10
	Penicillium spp. (total)	28	56	64	58	72	01	56
C horizon (C_1)	*Penicillium decumbens*	0	13	09	57	60	0	43
	Penicillium spp. (total)	0	22	09	68	62	0	47
	Cylindrocarpon radicicola	—	10	—	09	02	—	24
	T. viride	0	21	01	06	01	—	26
C horizon (C_2)	*Penicillium decumbens*	0	0	0	47	11	02	04
	Penicillium spp. (total)	0	0	0	54	13	02	02
	C. radicicola	0	22	01	11	01	09	08

The soil, the sampling procedure, and the method of isolating fungi from the soil samples (using the soil washing method) were as described previously (PARKINSON and BALASOORIYA, 1967).

Moisture content determinations were made on each of the seasonal soil samples.

To assess the degree of variation in the nature and frequency of the fungus flora of an horizon at one particular time (i.e. spatial variation), 5 pits were dug within the sampling area. From each exposed soil profile soil samples were taken from the H layer and the A_1 and C (C_1 and C_2) horizons. Again the sampling procedure and method of isolation of fungi were as previously described (PARKINSON and BALASOORIYA, 1967).

Moisture content determinations were made on each soil sample.

RESULTS

Variations in the moisture content and fungal « colonization index » of the different horizons in the investigation of seasonal variations are given in Table I. Because of the method of study, absolute values of amounts of fungi in soil samples was not allowed, however some indication of the degree of colonization of washed particles can be obtained from the expression:

% particles colonized × average number of colonies/particle which represents the colonization index.

Data on the seasonal variations in percentage frequency of occurrence of dominant fungi in the different horizons are given in Table II.

Table III gives data on the spatial variations in moisture content and colonization indices of the H layer, A_1 and C horizons (determined from samples all taken at the same time), whilst Table IV indicates variations in the occurrence of dominant fungi in these spatial samples.

TABLE III

Spatial variations in moisture content and colonization index in the H layer and A_1 and C horizons of the freshfield soil

Sample Number	Sampling Zone							
	H layer		A_1 horizon		C horizon (C_1)		C horizon (C_2)	
	Col. Index	% Moist.	Col. Index	% Moist.	Col. Index	% Moist.	Col. Index	% Moist.
1	220	66	1.0	3.5	56	1.0	12	3.1
2	220	72	125	9.2	54	2.7	19	3.6
3	226	62	120	8.6	46	2.5	9	3.9
4	232	62	4	2.0	39	1.2	30	3.4
5	182	63	10	5.3	73	2.2	7	3.4

DISCUSSION

Attempts were made during this investigation to determine whether there were detectable seasonal variations in the mycofloras in different parts of the soil profile of the pinewood soil, and to what extent any detected variations

TABLE IV

Spatial variations in percentage frequency of occurrence of dominant fungi in the H layer and A_1 and C horizons of the freshfield soil

Sampling Zone	Dominant Fungi	Spatial Samples				
		1	2	3	4	5
H layer	*T. viride*	62	62	68	80	66
	M. marburgensis	26	27	24	28	16
	M. hygrophila	28	36	16	34	34
	P. lividum	20	02	26	26	18
	P. citrinum	34	31	18	20	20
	P. spp. (total)	90	69	80	90	54
A_1 horizon	*P. decumbens*	—	38	61	—	28
	T. viride	—	34	13	—	—
	O. fuscum	04	01	—	02	03
	Dark St. GRN	03	03	—	—	—
	P. spp. (total)	—	53	78	—	29
C horizon (C_1)	*P. decumbens*	17	24	11	05	28
	C. radicicola	37	24	25	35	18
	T. viride	03	06	02	08	05
	P. spp. (total)	21	26	13	05	38
C horizon (C_2)	*P. decumbens*	02	02	03	06	04
	C. radicicola	04	31	19	36	09
	P. spp. (total)	02	02	03	06	04

were influenced by the heterogeneous nature of the different horizons. Views on the effect of season on populations of soil fungi are conflicting, however many of these views have been derived from studies in which no attempt was made to assess spatial, as well as seasonal, variations.

WILLIAMS (1962), working on a much older iron-humus podzol, studied this problem and concluded that, in the mineral horizons of the soil, the spatial variations in mycofloras he observed were greater than any observed seasonal variations. In the litter layers of coniferous forest soils definite successional sequences of fungi occur (KENDRICK and BURGES, 1962), these resulting from the presentation to the soil surface new nutrient rich substrates for colonization and utilization.

In the more stable fungal communitites of the mineral horizons beneath the insulating layers of litter, the effect of adverse environmental conditions presumably will be to induce resting or relatively inactive conditions (in the form of spores, chlamydospores, resting mycelia, sclerotia, rhizomorphs, etc.). However, little information is available regarding seasonal adaptations of saprophytic soil fungi.

In the H layer no recognizable seasonal trends were observed, any fluctuations in the mycoflora being apparently independent of season (apart from a lower colonization index at the February sampling time).

In the mineral horizons, no marked seasonal fluctuations in fungal species were apparent except for slightly increased incidence of *Penicillium* spp. during the spring and early summer. However in the 2 zones of the C horizon (C_1 and C_2) maximum colonization indices occurred in the April samples (the time of maximum soil moisture content). In all the mineral horizons the colonization of both mineral particles and organic fragments, as well as the overall colonization index appeared in general to be governed more by fluctuations in soil moisture than temperature. In the C horizon there was a lack of colonization when the soil moisture content dropped below a certain critical level (e.g. at the October and August sampling times). The ability of fungi from this soil to withstand low moisture contents has been examined in detail (SHAMEEMULLAH, 1965).

In the assessment of spatial variation of the mycofloras of the H layer, A_1 and C horizons it has been shown that for the H layer the spatial variations were not so great as the seasonal variations. In this layer there was little correlation between colonization index and moisture content (neither spatial nor seasonal variations in moisture content in this layer were great and never fell to a level which might limit fungal development).

In the mineral horizons the data provided on spatial samples substantiates previous comments on the effect of soil moisture content on fungal colonization. In the climatic conditions prevalent at the experimental site rainfall was more or less uniformly distributed throughout the sampling period and was therefore independent of season. Differences can be seen in degree of variation of colonization indices in the seasonal and spatial samples but these are are relatable to moisture content.

Thus it appears, from the data presented, that qualitative and quantitative fluctuations in the mycofloras of the pinewood soil at Freshfield cannot be interpreted as representing seasonal fluctuations. These results are in agreement with those of WILLIAMS and PARKINSON (1964) for podzolized soil under *Pinus silvestris*.

SUMMARY

A study of the seasonal and spatial fluctuations of fungal populations in a pinewood soil was carried out. Results generally revealed no significant qualitative or quantitative changes throughout the year. The degree of fungal colonization of soil microhabitats was shown to be governed more by soil moisture content than by any seasonal factor (in this experimental area rainfall was relatively uniform throughout the year).

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